What does a VA look like?

All VAs involve answering a set of questions about the target

- Focus
- Target
- Information source
- Output
  - Score/rank
  - Map
  - Text
  - Table
  - Graph

Integrating Climate Change Vulnerability Assessments into Adaptation Planning

A case study using the NatureServe Climate Change Vulnerability Index to inform conservation planning for species in Florida

A Report Prepared for the Florida Fish and Wildlife Conservation Commission

Natalie Dubois, Astrid Caldas, Judy Boshoven & Aimee Delach

DEFENDERS OF WILDLIFE

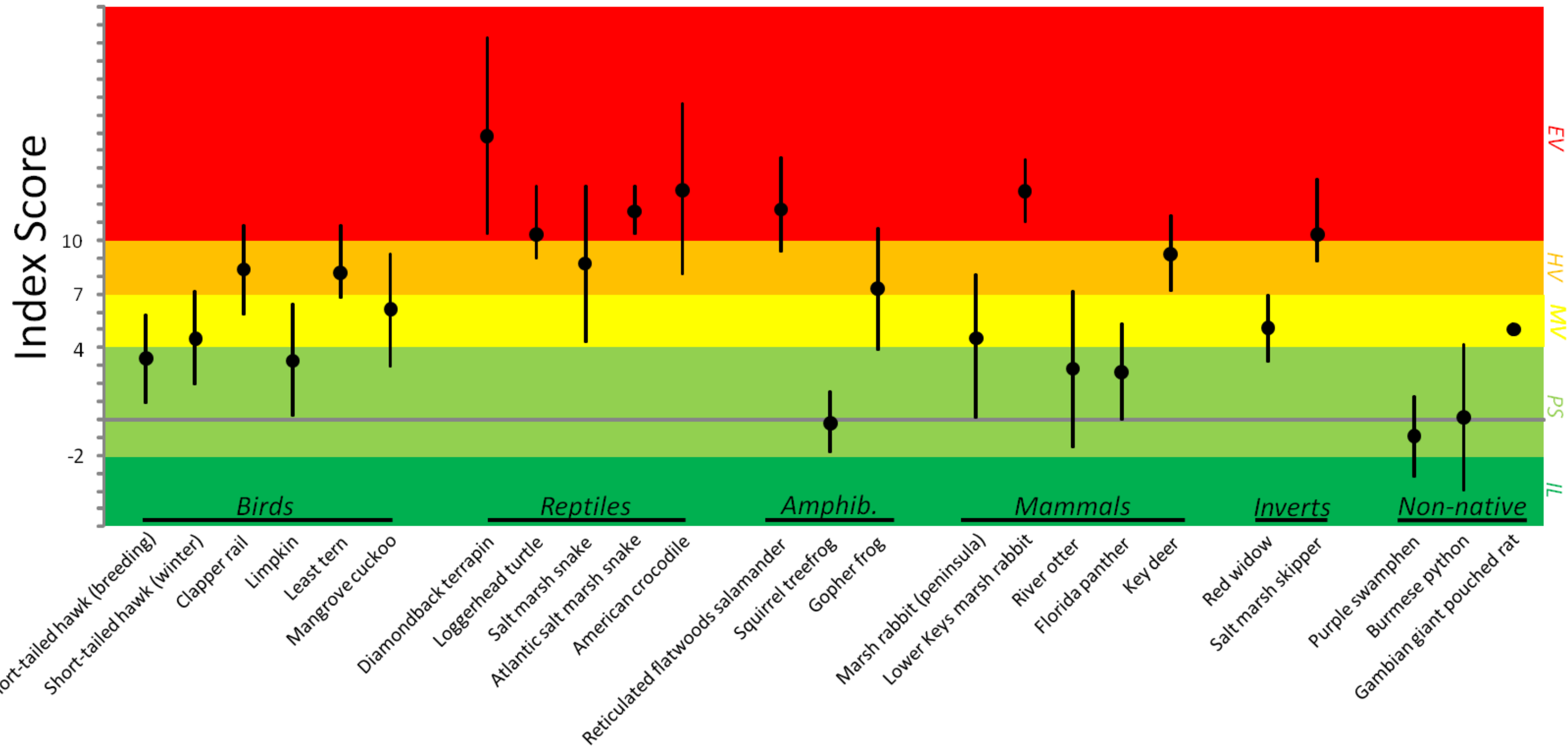

Figure 5. CCVI Index scores for the indicated species within their ranges in Florida. The index score (black circle) is shown along with the range of scores produced by the Monte Carlo simulation. Categorical ranks are coded by color: "Extremely Vulnerable" (red), "Highly Vulnerable" (orange), "Moderately Vulnerable" (yellow), "Not Vulnerable/Presumed Stable "(green), "Not Vulnerable/Increase Likely" (dark green).

CCVI to uncertainty in the parameter estimates, we report scores somewhat differently from this standard output. We report the numeric index score associated with the categorical rank along with the range of scores produced by the Monte Carlo simulation.

The species accounts summarize the information provided by the species experts and the input parameters used for the CCVI for each species. More information on how the factors are scored is available in Young et al. (2010). Version 2.1 of the CCVI was used in this analysis.

Literature Cited

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A1. SHORT-TAILED HAWK *(Buteo brachyurus)*

Species Expert(s): Ken Meyer and Karl Miller

Within the United States, short-tailed hawks are found only within Florida but are much more widely distributed throughout Central and South America (Miller and Meyer 2002). Their habitat generally includes mangroves, coastal marshes, swamp forests, pine savannas, prairies, and pastures, as well as suburban settings with trees and shrubs. Florida's population is distinct from other populations and is separated from the closest population in Mexico by more than 800 kilometers. The Florida population remains in the state year-round but migrates to the southern peninsula and Florida Keys during the winter (Miller and Meyer 2002).

Distribution Data

The CCVI utilizes distribution data to calculate estimates of relative exposure for each species. Data considered as part of this assessment (Figure A1-1) included a range map from NatureServe (Ridgely et al. 2003), a potential habitat model (phm) developed by FWC (Endries et al. 2009), and FNAI element occurrence data (FNAI 2011). The species experts felt that the NatureServe range underestimated the actual breeding distribution, which is not confined to the central ridge as indicated, and overestimated the wintering range (indicated as "year round"), which occurs south of Lake Okeechobee but tends to be concentrated in the southern Everglades. Based on these comments, we did not include the NatureServe range in our analysis. The potential habitat model was considered adequate but a bit conservative, with several known inaccuracies. The species experts are currently working with FWC to update the potential habitat model. We also ran the assessment using counties with known occurrences based on the Florida Breeding Bird Atlas (FWC 2003) to estimate the species' distribution. FNAI occurrence data included 43 records distributed throughout the peninsula, including two records in the Keys. Although we included the occurrence data for comparison with other distribution data, we did not specifically evaluate the how well the element occurrences approximated the range extent as part of our assessment.

Initially, we asked the species experts to complete the worksheet based on the distribution maps as provided, which combines both the breeding and

wintering range. However, after consulting with the species experts, it became apparent that the wintering range differs in exposure (particularly sea level rise) and other associated factors, and there was concern that the unique aspects of vulnerability associated with these different spatial and temporal components of the life history might not be captured in a combined analysis. In order to explore this issue, we ran two separate analyses, one focused on the breeding distribution and the other on the winter distribution. There was a natural break in the potential habitat south of Lake Okeechobee which we used to delineate the winter range (Figure A1-1). We used this same line to delineate the FNAI occurrence data. The winter range is essentially a portion of the breeding range, with the exception of the Florida Keys, where birds winter but do not breed (K. Meyer and K. Miller, pers. comm.). However, none of the datasets shown in Figure A1-1 currently include the Florida Keys as part of the breeding range.

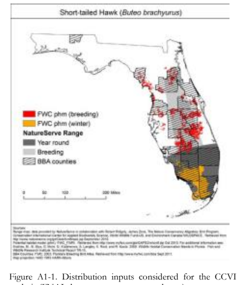

Figure A1-1. Distribution inputs considered for the CCVI analysis (FNAI element occurrences not shown).

Exposure

We obtained downscaled data from Climate Wizard (Zganjar et al. 2009) for the state of Florida for mid-century projections based on the mean ensemble model under the A1B emissions scenario. Moisture data, in the form of the Hamon AET: PET moisture metric were downloaded from NatureServe and are derived from Climate Wizard temperature and precipitation projections for mid-century under the A1B emissions scenario. To use the CCVI, the percentage of the distribution that is exposed to a particular range of projected change in temperature or moisture is calculated in ArcGIS by overlaying the exposure data on the distribution or occurrence data (Tables A1-1 and A1-2). For point data sets, we assigned a single exposure value to each of the points based on the overlay.

Indirect Exposure

Sea level rise (B1). Species experts assigned different scores for the winter and breeding distributions. Both reviewers estimated that 10% or less of the breeding range would be impacted by a 1-meter sea level rise and provided estimates of 25% and 50-90% for the winter range. These estimates corresponded to a score of *neutral* for the breeding range and *somewhat increases* to *increases* vulnerability in the winter range.

Potential impact of barriers on range shifts. Experts indicated that the species nesting habitat consists of mature swamp forest, adjacent mixed-species prairie and wooded habitats in various earlier successional stages. During the winter, this species congregates in mangrove estuaries in the Everglades. Both reviewers considered these habitats to be vulnerable to climate change, particularly wintering habitat. Species occurring in habitats that are considered likely to persist despite climate change would be scored as "neutral" for factors B2a and B2b, which focus on the potential impact of barriers on climate-induced range shifts.

Natural Barriers (B2a). The issue of scale came up in reviews' responses to this factor. One reviewer scored this factor at a state-wide scale, considering natural barriers to completely surround the species' range in the form of the ocean to the west, south and east, and unsuitable habitat to the north. However, both

Table A1-1. Projected temperature exposure for short-tailed hawk in the assessment area. The percentages are used to calculate the temperature component (E_T) of the exposure metric. See Young et al. (In press) for details.

Data set → (Distribution)	FWC phm Breeding	FWC phm Winter	BBA counties	FNAI Occur.
> 5.5°F warmer	0%	0%	0%	0%
5.1 - 5.5 °F	0%	0%	0%	0%
4.5 - 5.0 °F	0%	0%	0%	0%
3.9 - 4.4 °F	0%	0%	3%	0%
< 3.9°F warmer	100%	100%	97%	100%
(E_T)	*0.4*	*0.4*	*0.4*	*0.4*

Table A1-2. Projected moisture exposure (based on the Hamon Index) for short-tailed hawk in the assessment area. The percentages are used to calculate the moisture component (E_M) of the exposure stress. See Young et al. (In press) for details.

Data set → (Distribution)	FWC phm Breeding	FWC phm Winter	BBA counties	FNAI Occur.
< -0.119 (Driest)	0%	0%	0%	0%
-0.119 - -0.097	12%	27%	6%	7%
-0.096 - -0.074	61%	73%	49%	72%
-0.073 - -0.051	26%	0%	42%	19%
-0.050 - -0.028	1%	0%	3%	2%
> -0.028 (No change)	0%	0%	0%	0%
(E_M)	*1.3*	*1.3*	*1.3*	*1.3*

experts agreed that the species would be able to track shifts in habitat that might occur under climate change. While the unsuitable habitat to the north may change currently function as a barrier to short-tailed hawk distributions, it was not clear from this discussion that this unsuitable habitat would represented a barrier to habitat shifts under climate change. For the breeding distribution, we conservatively assigned this factor a score of *neutral.* Reviewers did not directly specify whether natural barriers would be expected to impact habitat in the wintering range, but based on the habitat we also considered the impact of natural barriers on winter habitat to be *neutral.*

Anthropogenic barriers (B2b). One reviewer mentioned the impact of future urban development along the coasts and inland expansion with climate change, selecting the description corresponding to increases vulnerability. However, in order to maintain consistency across the different species' assessments, we captured the potential for increased interior development in response to human migration away from the coast in factor B3 and so have not included it here. In the breeding range, a large portion of the breeding habitat occurs in the interior peninsula and so coastal development would not be expected to pose a major barrier to the anticipated direction of habitat shifts to the north. In the wintering range, current habitat occurs primarily in protected areas. In considering the ability of the species to navigate around anthropogenic barriers, both reviewers agreed that short-tailed hawk could likely traverse existing barriers as the species migrates significant distances within the Florida peninsula. We adjusted the scores for this factor to *neutral* for both breeding and winter range.

Land Use Changes Resulting from Human Responses to Climate Change (B3). One expert considered risk from greater human development and density in the nesting range with inland movement from the coasts and an increasing ability to developing land acreage under drier conditions. In follow up discussion, the potential for increased forestry in these areas was also mentioned. Both reviewers expressed uncertainty in the scale and impact that these activities would have on the species. We captured this uncertainty by assigning scores of *neutral*, *somewhat increases* and *increases* vulnerability for the breeding range. We considered this factor to be *neutral* for the winter range, which has large overlap with a number of existing protected areas.

Sensitivity

Dispersal and movement (C1). Both experts characterized the species as having excellent dispersal. The species regularly migrates hundreds of kilometers up and down the Florida peninsula. This factor was scored as *decreases* vulnerability.

Historical thermal niche (C2ai). This factor is intended to approximate the species' temperature tolerance at a broad scale by looking at large-scale temperature variation that a species has experienced in the past 50 years within the assessment area. This is calculated as the difference between the highest mean monthly

maximum temperature and lowest mean monthly minimum temperature for each cell. We assessed this factor using the maps provided by NatureServe. We included all scores that applied to any part of the species' range in Florida, which corresponded to scores of *increases* and *greatly increases* vulnerability.

Physiological thermal niche (C2aii). One species expert characterized the species as showing a preference for environments towards the warmer end of the spectrum and the other expert indicated no associate with a particular thermal environment. We included scores of *somewhat decreases* and *neutral* to capture the range in reviewer responses.

Historical hydrologic niche (C2bi). This factor is intended to capture the species' exposure to past variation in precipitation as a proxy for tolerance to large-scale variation in precipitation. The factor is assessed by calculating the range in mean annual precipitation for the period of 1951-2006 observed across the species' distribution in the assessment area. We overlaid the species' distribution (combining the breeding and wintering ranges) with the maps provided by NatureServe to assess this factor. The calculated values for variation in precipitation corresponded to *somewhat increases* vulnerability using the potential habitat model and BBA counties and *increases* vulnerability using the FNAI occurrences as a proxy for the species' distribution.

Historical precipitation exposure
FWC phm/BBA counties: 46 - 59 inches
FNAI occurrences: 49 - 56 inches

Physiological hydrologic niche (C2bii). Both experts cited reliance on mature swamp forest and wetland drainages during nesting. In addition the species relies on various wetlands in southern Florida for concentrations of migratory prey during the winter. One of the reviewers selected the description associated with a score of "increases" vulnerability for this factor, whereas the other reviewer indicated that there was insufficient information to select a response. Based on the written comments associated with this factor and our follow up discussions, we have adjusted the scores to capture the uncertainty associated with the potential level of impact on the species by including scores of *somewhat increases* and *increases* vulnerability for this factor.

Impacts of Changes to Specific Disturbance Regimes (C2c). Fire and drought were considered to have a potentially negative impact on nesting and cover habitats as well as prey populations. The uncertainty associated with the projected impacts was captured in the range of scores selected by the reviewers, which included *neutral*, *somewhat increases* and *increases* vulnerability.

Dependence on ice, ice-edge, or snow cover habitats (C2d). All species in Florida were scored as *neutral* for this factor.

Physical habitat specificity (C3). Reviewers did not feel that the idea of specificity to a particular geologic feature or derivative was particularly relevant to this species, corresponding to score of *somewhat decreases* vulnerability.

Dependence on other species to generate habitat (C4a). The required habitat was not considered to be dependent on a very small number of species. Both reviewers assigned a score of *neutral* to this factor.

Dietary versatility (C4b). Experts indicated that the diet was fairly flexible, i.e. not dependent on one or a few species, although they considered the winter diet potentially more restricted due to the reliance on migratory birds that concentrate in southern Florida. We captured this dependence by including scores of *neutral* and *somewhat increases* vulnerability for the winter range and *neutral* for the breeding range.

Pollinator versatility (C4c). Not applicable.

Dependence on other species for propagule dispersal (C4d). The species disperses on its own. This factor was scored as *neutral.*

Other interspecific interactions (C4e). Additional interspecific interactions that might affect vulnerability were not identified. This factor was scored as *neutral.*

Table A1-3. Scores assigned to factors associated with vulnerability to climate change for short-tailed hawk in the winter range in Florida. Bolded factors were associated with higher levels of uncertainty by the expert reviewers. Not all scores can be assigned to all factors as indicated by dashes.

Vulnerability factor	GI	I	SI	N	SD	D	unknown or n/a
Sea level rise		•	•			--	
Natural barriers				•	--	--	
Anthropogenic barriers				•	--	--	
Human responses to CC	--			•			
Dispersal						•	
Historical thermal niche (GIS)	•	•				--	
Physiological thermal niche				•	•	--	
Historical hydrologic niche (GIS)			•			--	
Physiological hydrologic niche		•	•			--	
Disturbance regimes	--	•	•	•			
Ice and snow				•	--	--	
Physical habitat specificity	--				•		
Biotic habitat dependence				•	--	--	
Dietary versatility	--		•	•		--	
Biotic dispersal dependence	--			•	--	--	
Other interactions: none	--			•	--	--	
Genetic variation	--					--	•
Phenological response	--					--	•

Table A1-4. Scores assigned to factors associated with vulnerability to climate change for short-tailed hawk in the breeding range in Florida. Bolded factors were associated with higher levels of uncertainty by the expert reviewers. Not all scores can be assigned to all factors as indicated by dashes.

Vulnerability factor	GI	I	SI	N	SD	D	unknown or n/a
Sea level rise				•		--	
Natural barriers				•	--	--	
Anthropogenic barriers				•	--	--	
Human responses to CC	--	•	•	•			
Dispersal						•	
Historical thermal niche (GIS)	•	•				--	
Physiological thermal niche				•	•	--	
Historical hydrologic niche (GIS) [1]		(•)	•			--	
Physiological hydrologic niche		•	•			--	
Disturbance regimes	--	•	•	•			
Ice and snow				•	--	--	
Physical habitat specificity	--				•		
Biotic habitat dependence				•	--	--	
Dietary versatility	--			•		--	
Biotic dispersal dependence	--			•	--	--	
Other interactions: none	--			•	--	--	
Genetic variation [2]	--					--	•
Phenological response	--					--	•

[1] The higher value is assigned to this factor when using the element occurrences to estimate the species' distribution.
[2] We also ran the model with this factor scored as increases vulnerability.

Measured genetic variation (C5a). Reviewers did not feel that there was enough information available to assess this factor. It was scored as *unknown.*

Occurrence of bottlenecks in recent evolutionary history (C5b). Reviewers did not feel that there was enough information available to assess this factor. The population in Florida is estimated at fewer than 500 individuals, but the population size has not changed in the last 100 years. It is unknown how recently the population separated from birds in the Caribbean. The definition for a population bottleneck provided by NatureServe for evaluation of this factor specifies that only species that suffered population reductions and then subsequently rebounded qualify. We scored this factor as *unknown* but also ran the model with this factor scored as *increases* vulnerability in order to evaluate the evaluate the model sensitivity to the assumption of reduced genetic variability.

Phenological response (C6). Reviewers were not aware of any research specifically assessing the correspondence between changes in seasonal dynamics and changes in the timing of phenological events. This factor was scored as *unknown.*

Documented or Modeled Response to Climate Change

We did not include these optional factors in the analysis.

Results

Short-tailed hawk ranked as "Not Vulnerable/ Presumed Stable" to climate change in the breeding range in Florida. When the analysis was restricted to

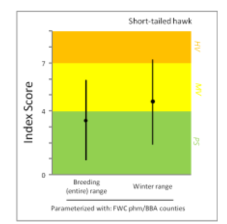

Figure A1-2. CCVI output (breeding and wintering range) for short-tailed hawk in Florida. The index score (black circle) is shown with the range of scores produced by the Monte Carlo simulation. Categorical ranks are coded by color: "Highly Vulnerable" (orange), "Moderately Vulnerable" (yellow), "Presumed Stable" (green).

the winter range, the vulnerability score increased to "Moderately Vulnerable." In the winter range, the primary factors contributing to vulnerability were sea level rise and the impact of potential changes in hydrology and disturbance regimes on migratory prey resources (Table A1-3). In the breeding range, potentially incompatible human responses to climate change posed a greater threat, but the impact of potential changes in hydrology and disturbance regimes on swamp forest were still important factors (Table A1-4). For both the breeding and winter range analyses, only two sensitivity factors were scored as unknown.

The three distribution data sets used in this analysis produced equivalent exposure metrics (Tables A1-1 and A1-2). The index score for the breeding range based on the FWC potential habitat model or BBA counties was 3.4 (range [0.9, 5.9]). Approximately 65% of the Monte Carlo simulations produced index scores in the "Presumed Stable" range, with the remaining simulations ranking as "Moderately Vulnerable." Including a score of "increases" vulnerability for factor C5b (*population bottlenecks*), increased the index rank to "Moderately Vulnerable" (index score: 4.8, range [2.4, 7.3]), with approximately 75% of simulations producing scores within this rank. Scores for the breeding range were somewhat higher when using FNAI occurrences parameterize the CCVI, with 72% of the Monte Carlo simulations producing scores in the "Moderately Vulnerable" range (index score: 4.7, range [2.3, 7.2]). The higher rank based on the FNAI occurrence data was due to the score assigned to factor C2b*i (historical hydrologic niche),* which is dependent on the distribution data, and not to differences in exposure.

Restricting the distribution to the winter range resulted in a score of 4.6 (range [1.9, 7.2], Figure A1-2) using the parameters associated with the potential habitat model or BBA counties, with approximately 68% of Monte Carlo simulations producing scores in the "Moderately Vulnerable" range and less than 1% ranking as "Highly Vulnerable." The remainder of the Monte Carlo simulations ranked as "Presumed Stable."

The species was flagged as potentially expanding range in the assessment area. This result is based on the low scores assigned to barriers combined with relatively high exposure and good dispersal while also taking the orientation of the assessment area relative to the species' range in to account.

The CCVI is intended to be used in combination with conservation status ranks. The global conservation status rank for short-tailed hawk is G4/G5. The species is ranked S1 in Florida.

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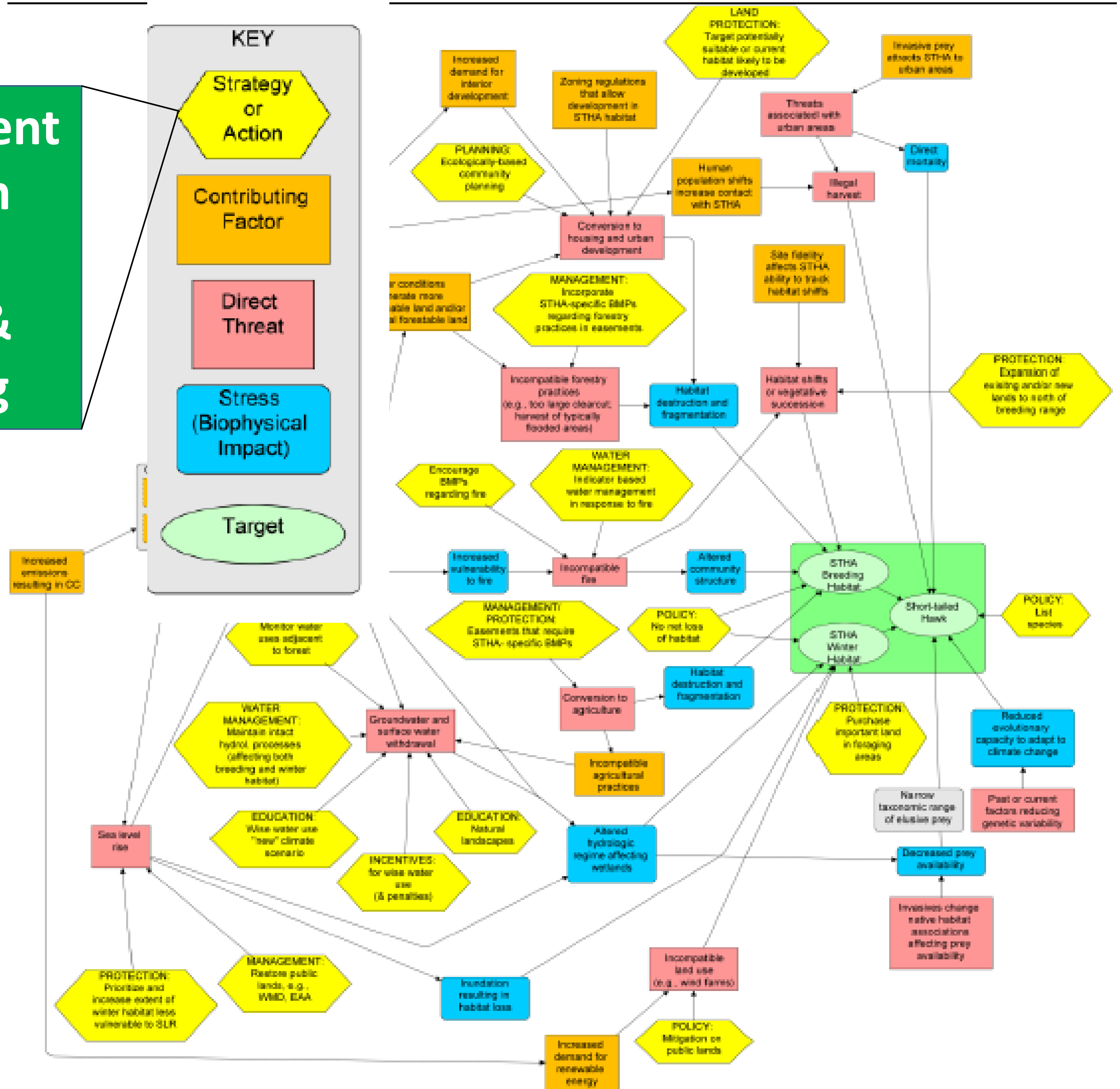
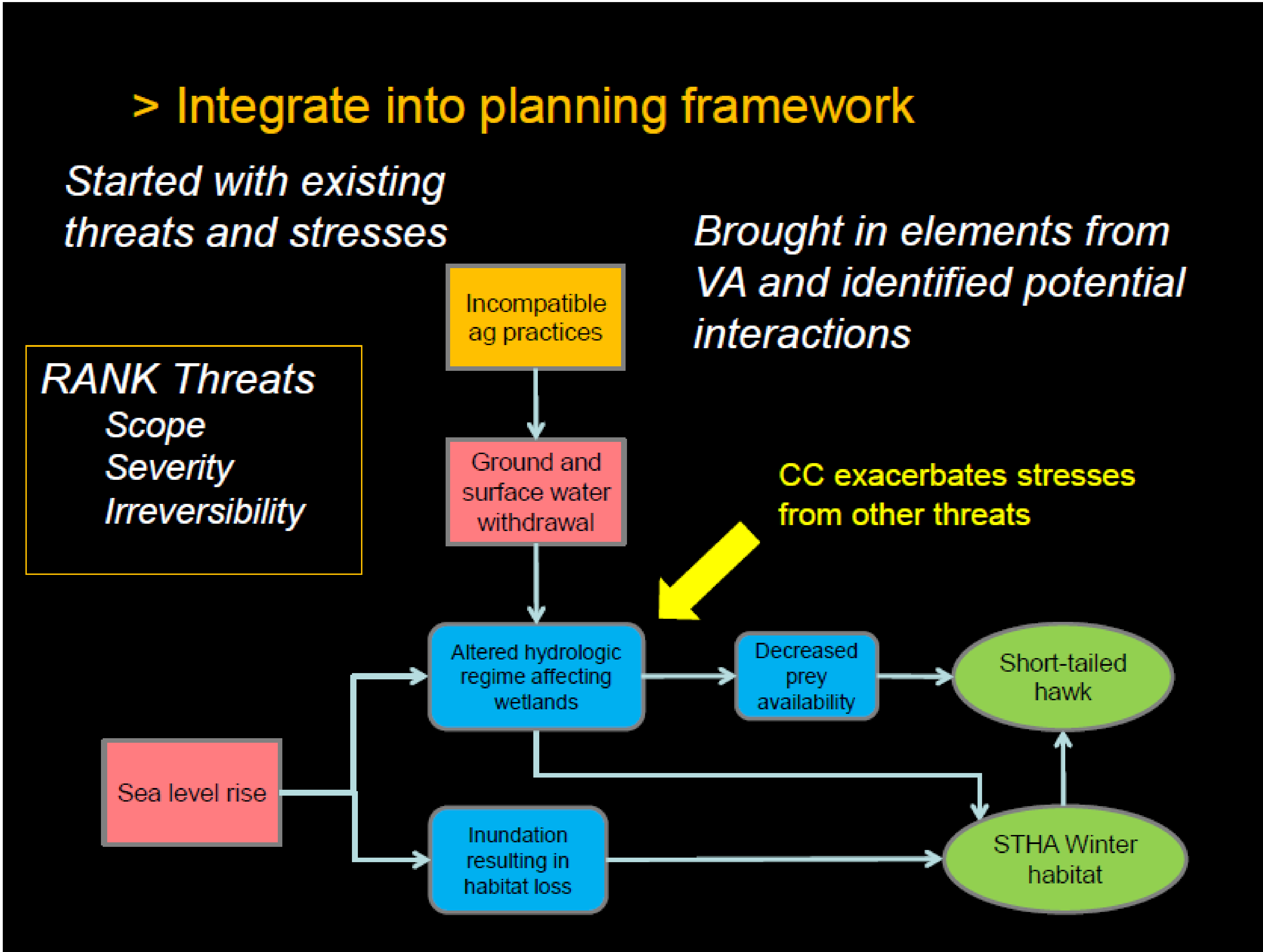
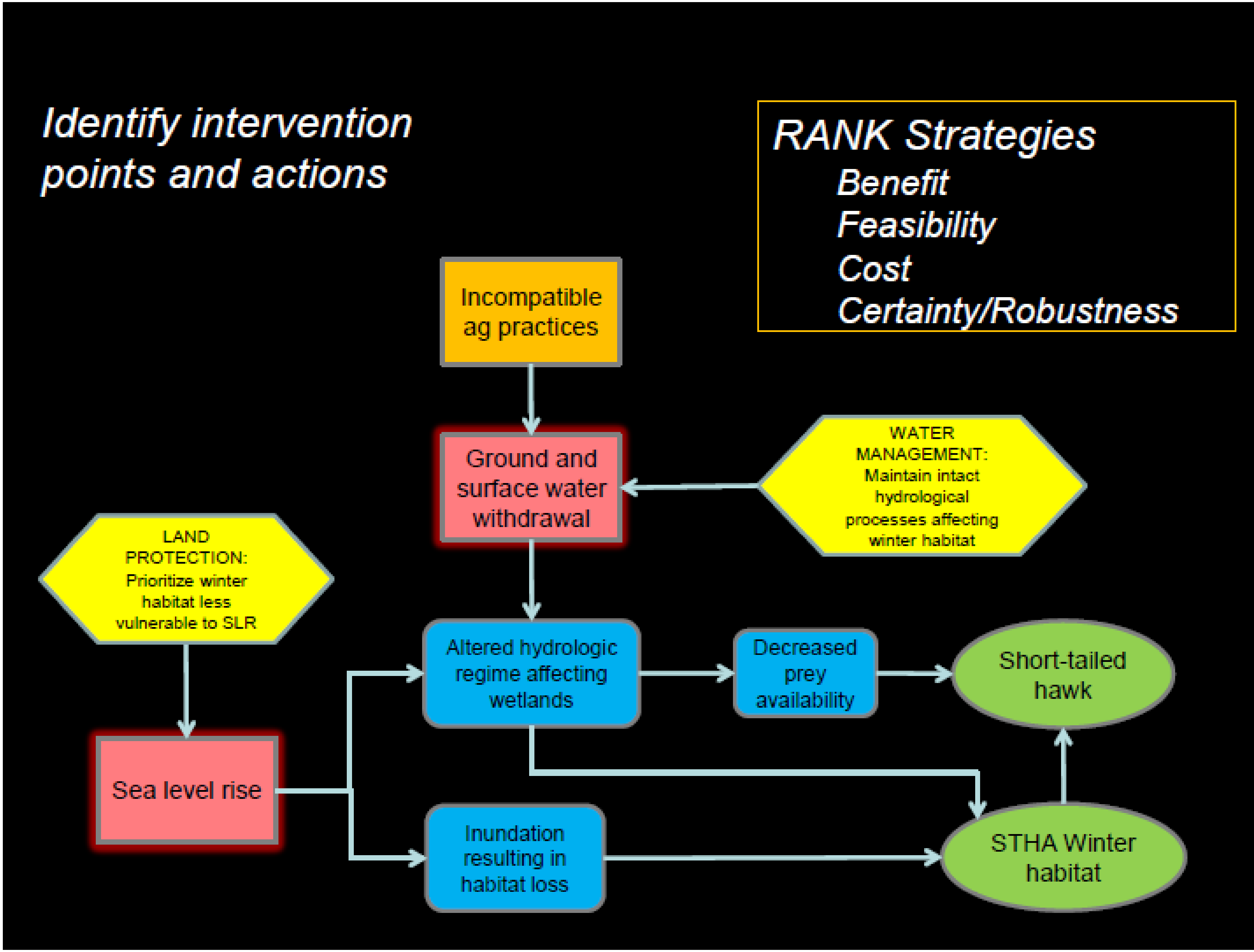
- Management
- Acquisition
- Policy
- Research & monitoring





> Integrate into planning framework
Started with existing threats and stresses
Brought in elements from VA and identified potential interactions
RANK Threats
Scope
Severity
Irreversibility
Incompatible ag practices
Ground and surface water withdrawal
CC exacerbates stresses from other threats
Altered hydrologic regime affecting wetlands
Decreased prey availability
Short-tailed hawk
Sea level rise
Inundation resulting in habitat loss
STHA Winter habitat


Identify intervention points and actions
RANK Strategies
Benefit
Feasibility
Cost
Certainty/Robustness
Incompatible ag practices
Ground and surface water withdrawal
WATER MANAGEMENT: Maintain intact hydrological processes affecting winter habitat
LAND PROTECTION: Prioritize winter habitat less vulnerable to SLR
Altered hydrologic regime affecting wetlands
Decreased prey availability
Short-tailed hawk
Sea level rise
Inundation resulting in habitat loss
STHA Winter habitat

esa ECOSPHERE

A climate-change adaptation framework to reduce continental-scale vulnerability across conservation reserves

Dawn R. Magness,[1,2,†] John M. Morton,[1] Falk Huettmann,[2] F. Stuart Chapin, III,[2] and A. David McGuire[2]

[1]U.S. Fish & Wildlife Service, Kenai National Wildlife Refuge, Soldotna, Alaska 99669 USA
[2]Institute of Arctic Biology, Department of Biology and Wildlife, University of Alaska, Fairbanks, Alaska 99775 USA
[3]U.S. Geological Survey, Alaska Cooperative Fish & Wildlife Research Unit, University of Alaska, Fairbanks, Alaska 99775 USA

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Abstract. Rapid climate change, in conjunction with other anthropogenic drivers, has the potential to cause mass species extinction. To minimize this risk, conservation reserves need to be coordinated at multiple spatial scales because the climate envelopes of many species may shift rapidly across large geographic areas. In addition, novel species assemblages and ecological reorganization make future conditions uncertain. We used a GIS analysis to assess the vulnerability of 501 reserve units in the National Wildlife Refuge System as a basis for a nationally coordinated response to climate change adaptation. We used measures of climate change exposure (historic rate of temperature change), sensitivity (biome edge and critical habitat for threatened and endangered species), and adaptive capacity (elevation range, latitude range, watershed road density, and watershed protection) to evaluate refuge vulnerability. The vulnerability of individual refuges varied spatially within and among biomes. We suggest that the spatial variability in vulnerability be used to define suites of management approaches that capitalize on local conditions to facilitate adaptation and spread risk across the reserve network. We conceptually define four divergent management strategies to facilitate adaption: refugia, ecosystem maintenance, "natural" adaptation, and facilitated transitions. Furthermore, we recognize that adaptation approaches can use historic (i.e., retrospective) and future (prospective) condition as temporal reference points to define management goals.

Key words: climate change; conservation reserve; National Wildlife Refuge System; prospective adaptation; resilience; retrospective adaptation; species extinction; U.S. Fish and Wildlife Service; vulnerability.

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† **E-mail:** Dawn_Magness@fws.gov

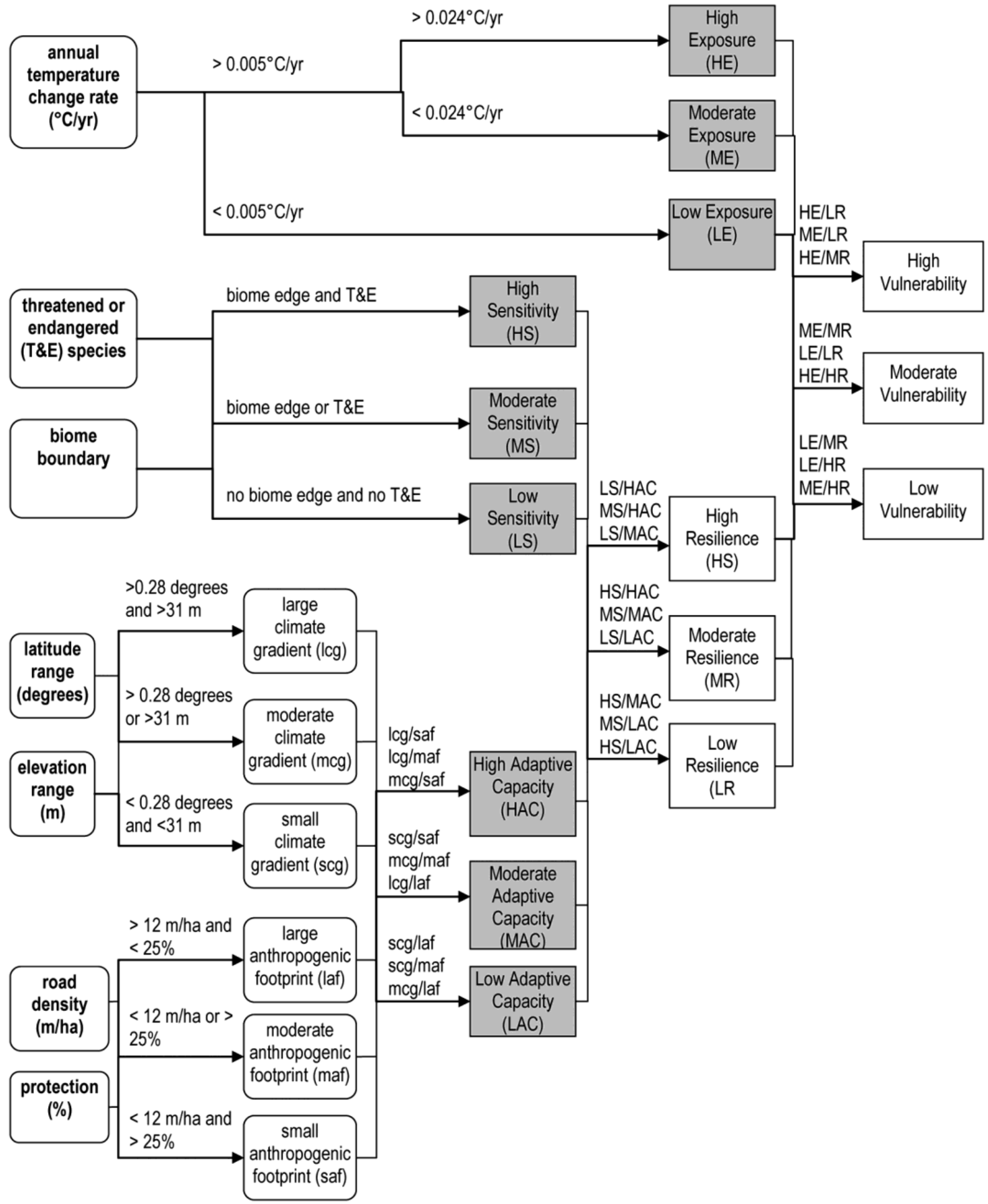


Fig. 1. Flowchart of variables with thresholds that define vulnerability categories.

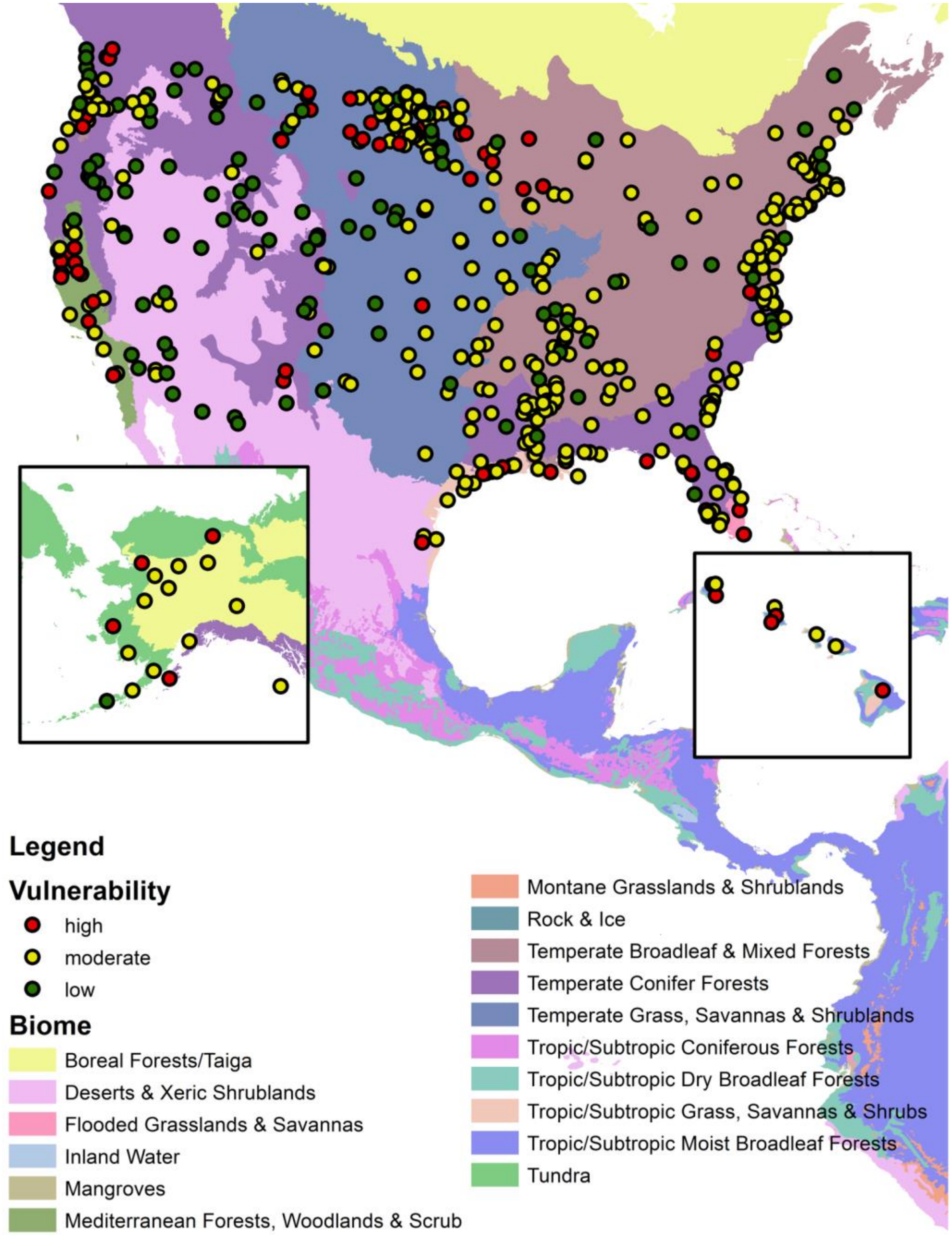


Fig. 3. Refuges sorted into high, moderate, and low vulnerability categories. Major biomes (Olson et al. 2001) are also shown.

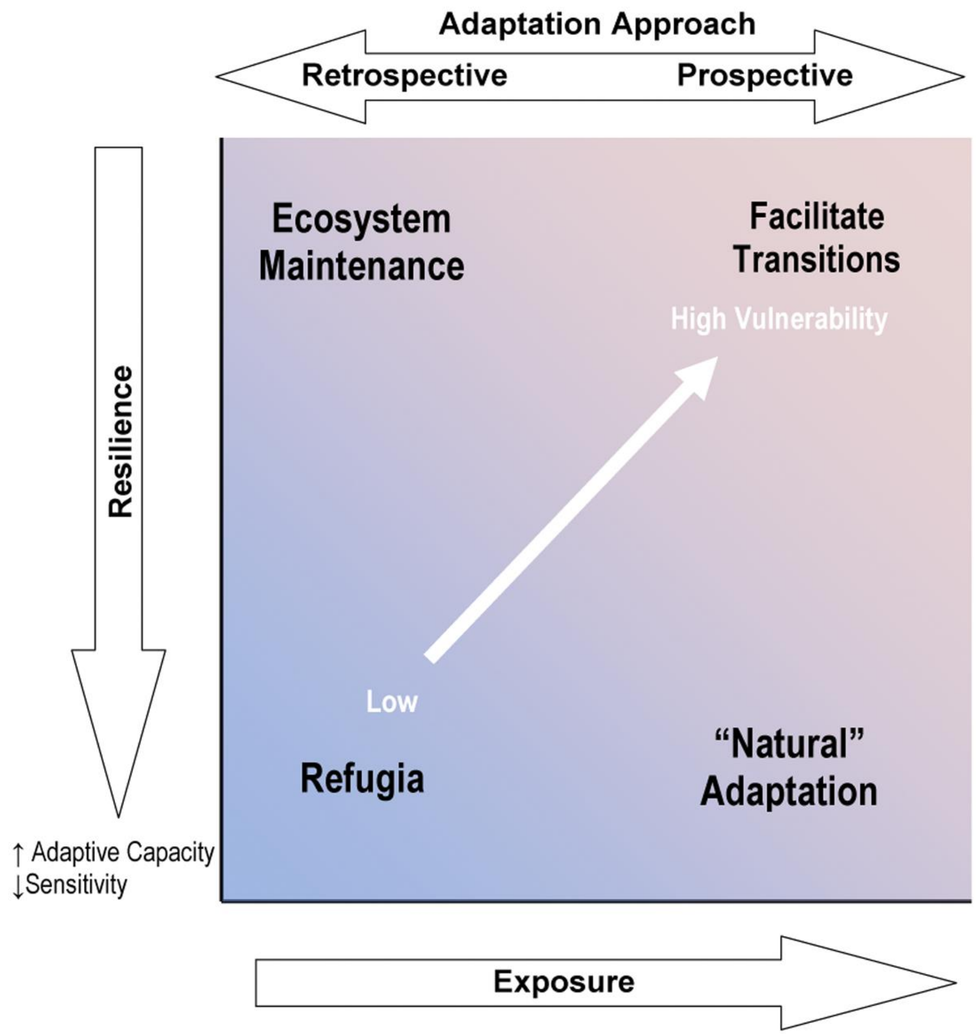


Fig. 2. Adaptation framework based on vulnerability. Management strategies can focus on refugia, ecosystem maintenance, "natural" adaptation, or facilitated transitions, based on relative levels of exposure and resilience (sensitivity and adaptive capacity).

A Climate-Informed Conservation Blueprint for the Greater Puget Sound Ecoregion

FINAL REPORT

March 1, 2012

Jessi Kershner and Eric Mielbrecht, EcoAdapt

In partnership with:
Marni Koopman and Jessica Leonard, Geos Institute

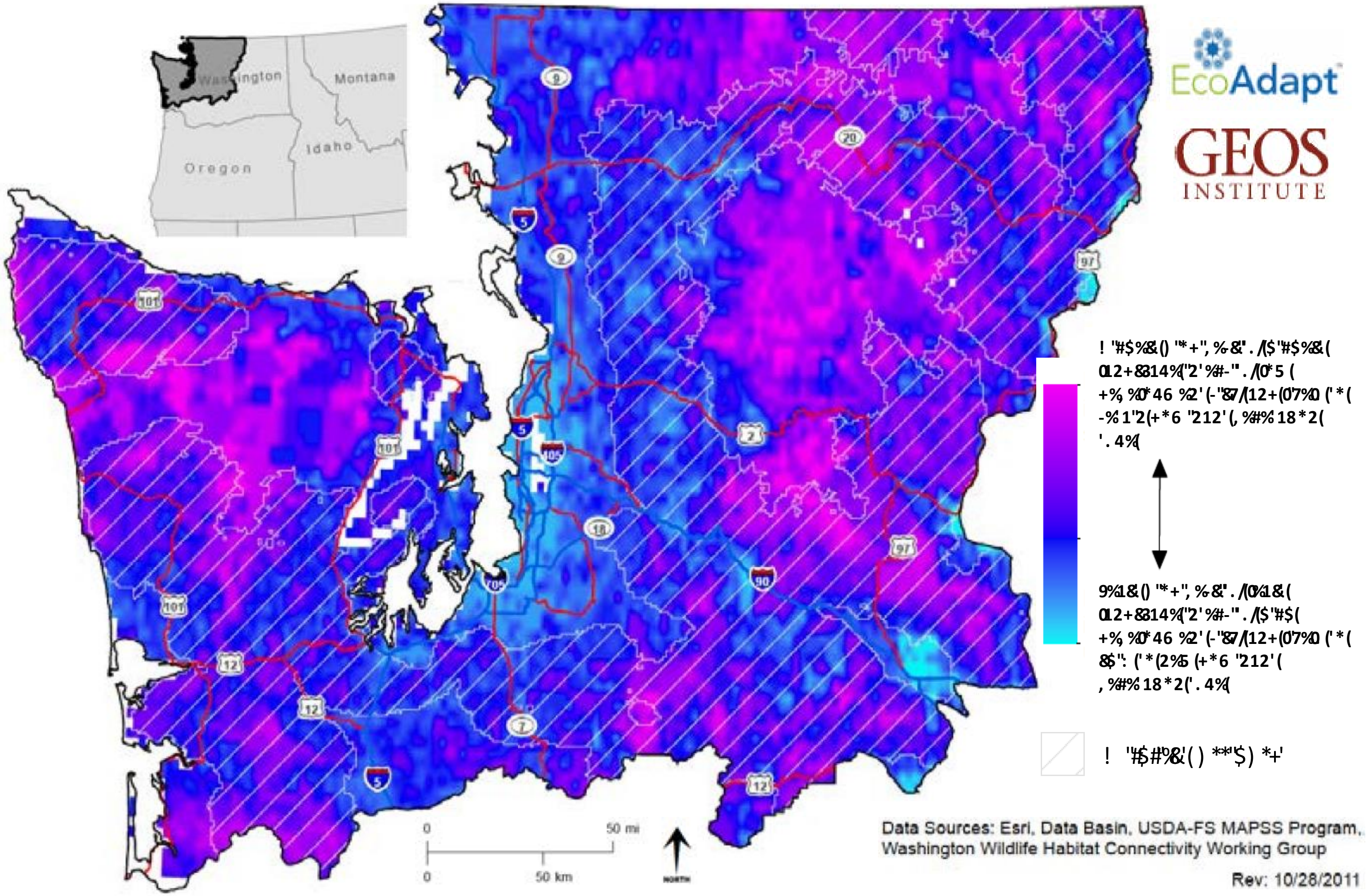
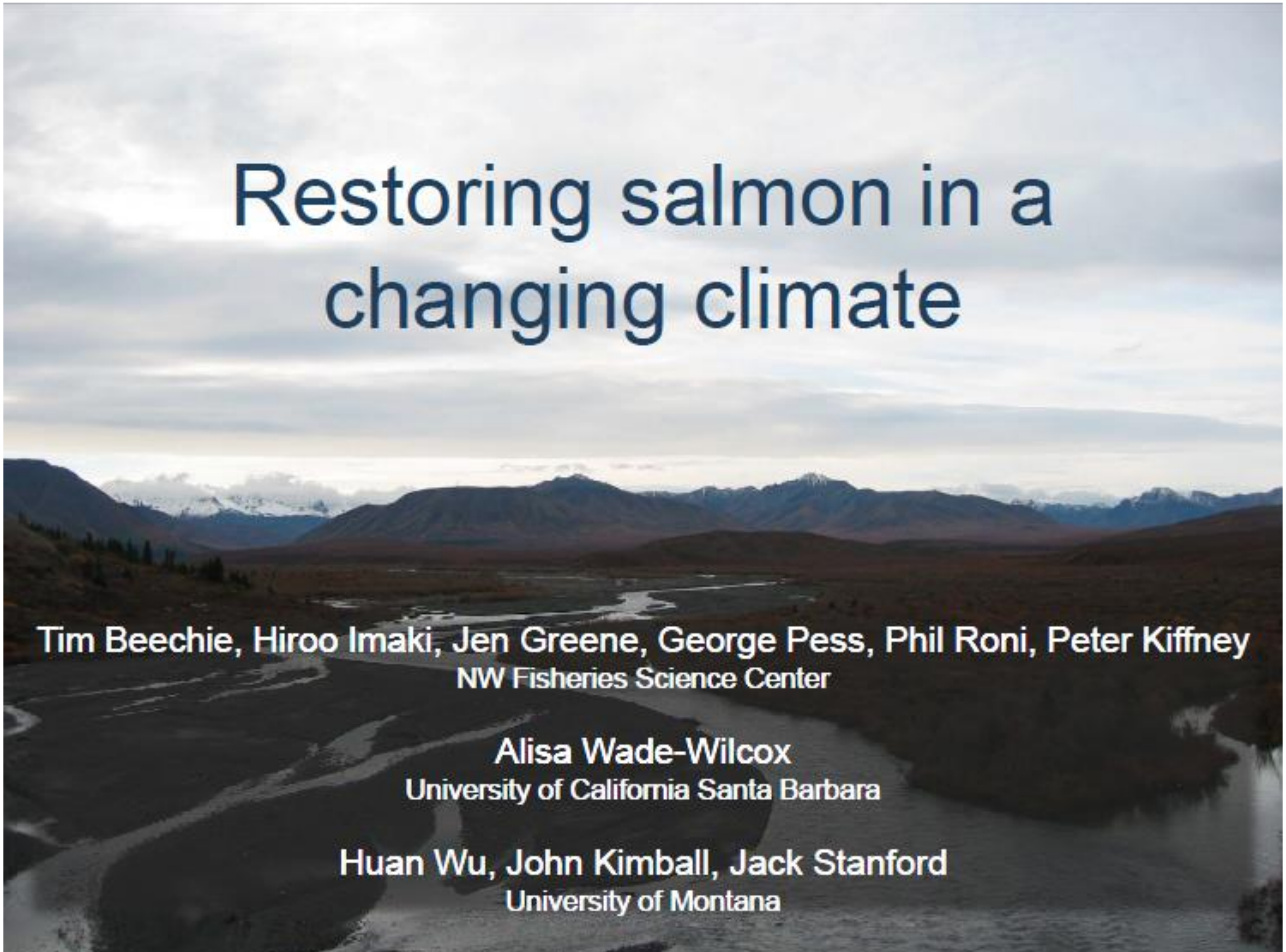


Figure 1-3. Master climate-informed conservation blueprint for the Greater Puget Sound ecoregion.



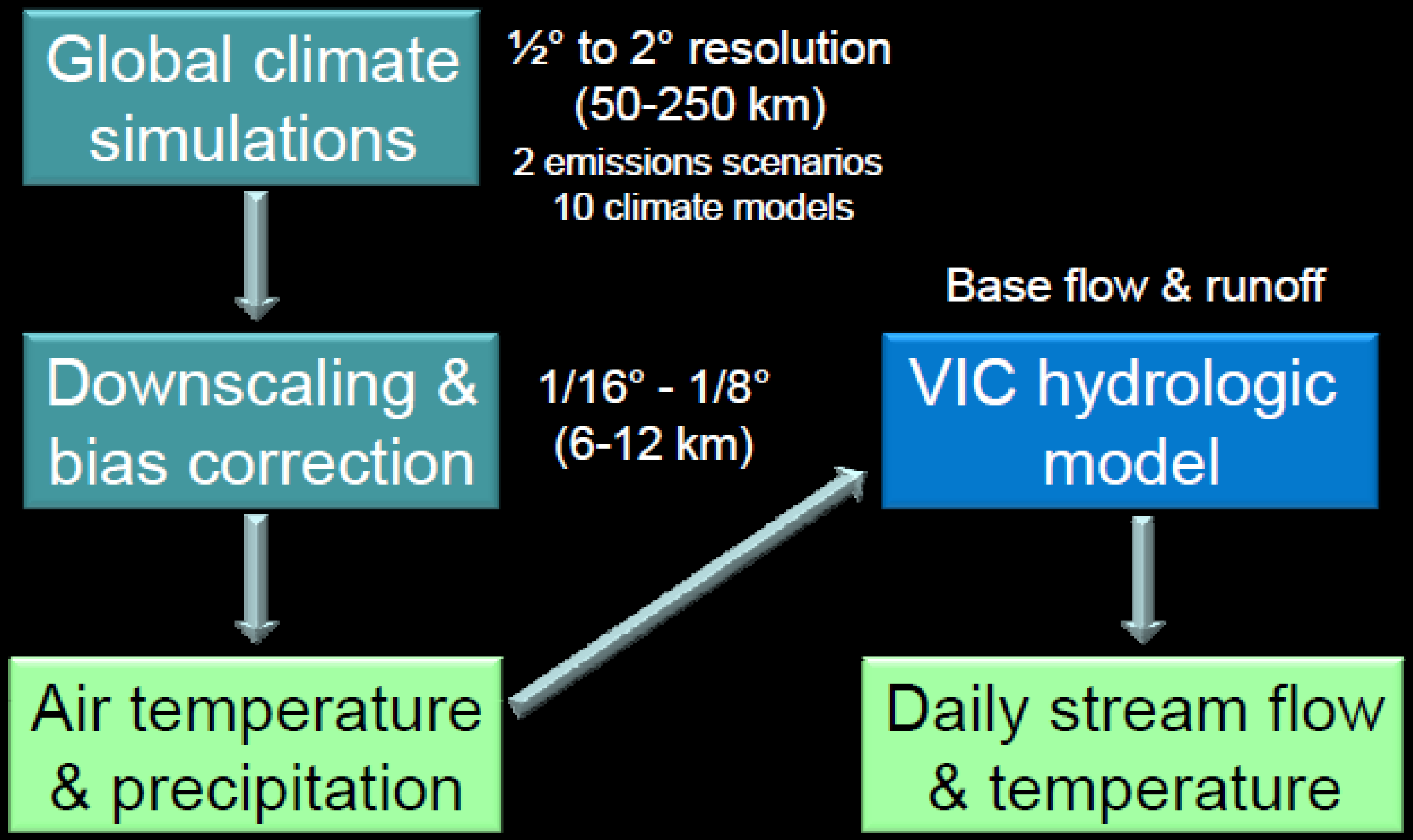
Restoring salmon in a changing climate

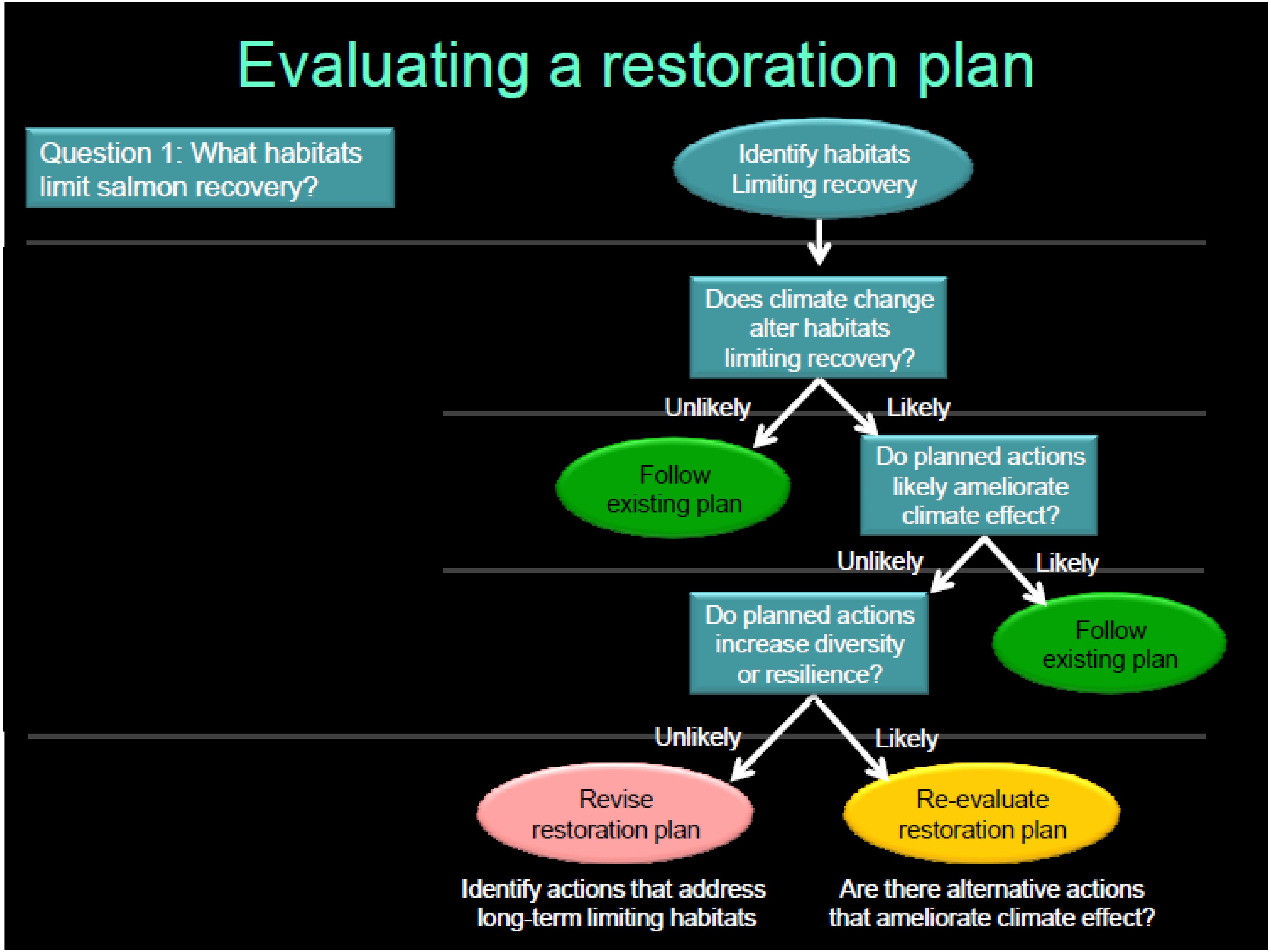
Tim Beechie, Hiroo Imaki, Jen Greene, George Pess, Phil Roni, Peter Kiffney
NW Fisheries Science Center

Alisa Wade-Wilcox
University of California Santa Barbara

Huan Wu, John Kimball, Jack Stanford
University of Montana

Predicting climate change effects




Evaluating a restoration plan
Question 1: What habitats limit salmon recovery?
Identify habitats Limiting recovery
Does climate change alter habitats limiting recovery?
Unlikely
Likely
Follow existing plan
Do planned actions likely ameliorate climate effect?
Unlikely
Likely
Do planned actions increase diversity or resilience?
Follow existing plan
Unlikely
Likely
Revise restoration plan
Re-evaluate restoration plan
Identify actions that address long-term limiting habitats
Are there alternative actions that ameliorate climate effect?

TACCIMO
Template for Assessing Climate Change Impacts and Management Options

Generate A Report

These tools facilitate a guided and standardized review of climate change content resulting in exportable reports. Note: “Explore” may be a useful place to begin for those unfamiliar with TACCIMO.

Climate Report	Use this application to generate custom climate reports for states, counties, and National Forests throughout the contiguous US.
Literature Report	This report generator produces an exportable report from the science literature content based on a series of user-defined selections.
Literature and Planning Report	This report generator produces an exportable report from the science literature and forest plan content based on a series of user-defined selections.
Planning Report	This report generator produces an exportable report from the forest plan content based on a series of user-defined selections.

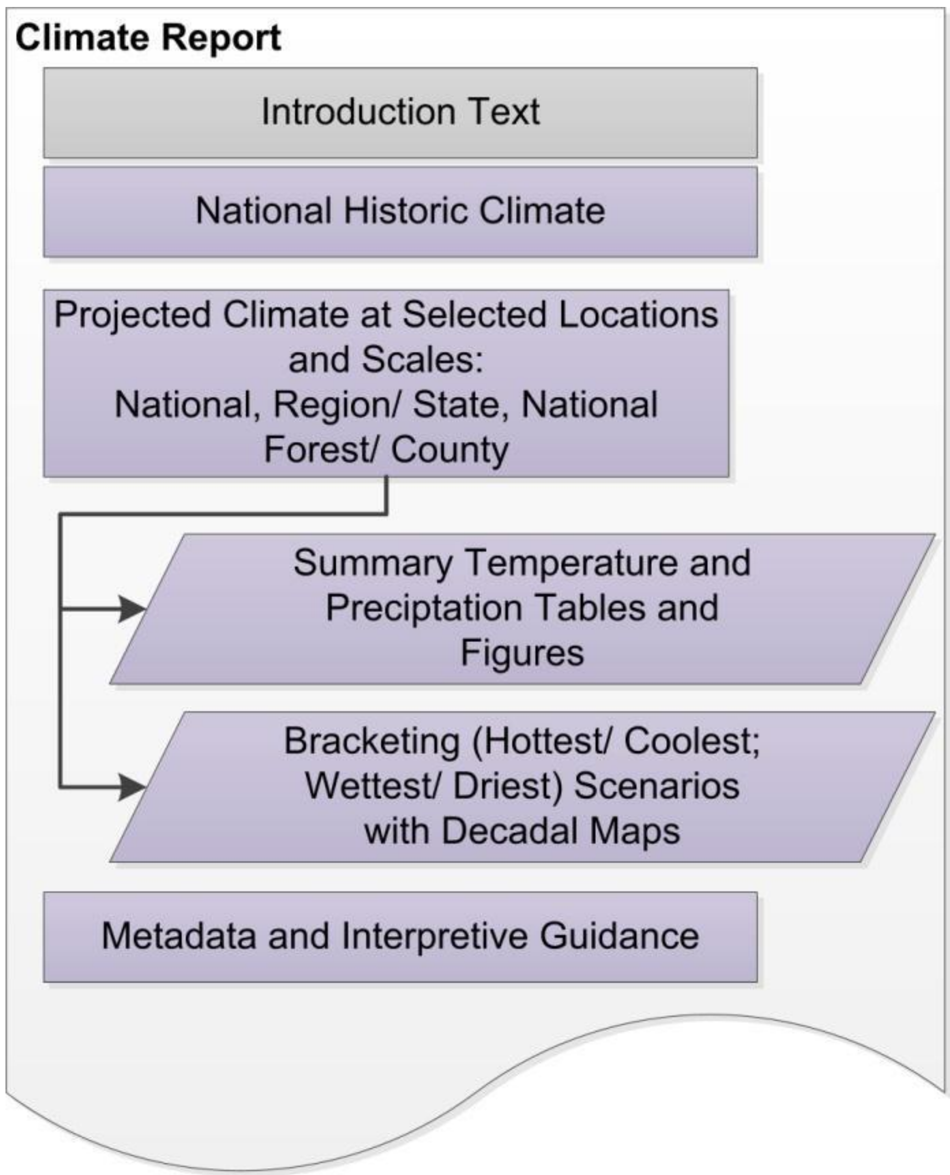


Figure 20—Diagram depicting the organization layout and placem

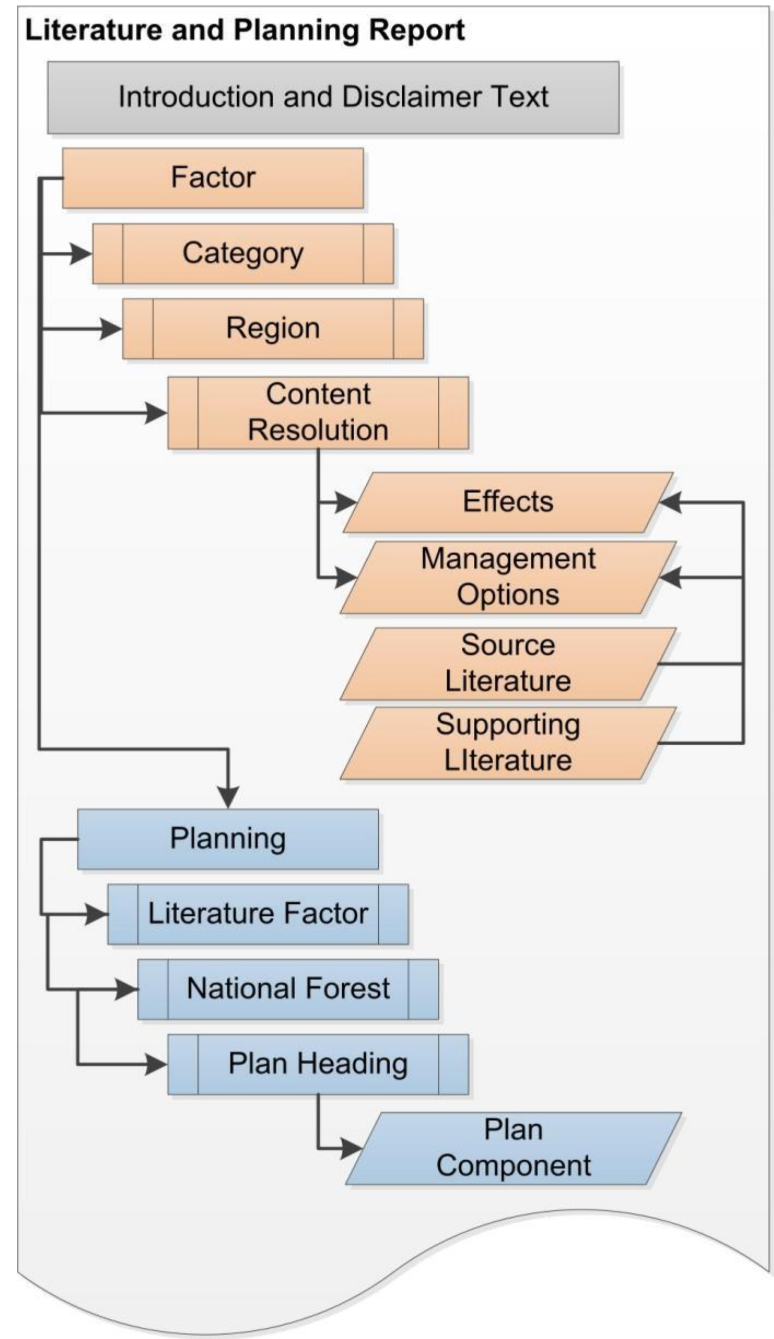


Figure 21—Diagram depicting nested organizational layout and re